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(54) **Floating platform assembly**

(57) A floating platform mooring system for use in exploiting subsea oil shoals consists of a platform structure (2) and an array of vertical tubular anchoring lines (3) connected to the uprights (1) of the platform structure (2) and to anchoring blocks (4) on the sea bed, the tubular sections which form the anchoring lines (3) being connected together in sequential order by welding. The platform may be floated to its mooring location with the anchor blocks suspended just below the platform.

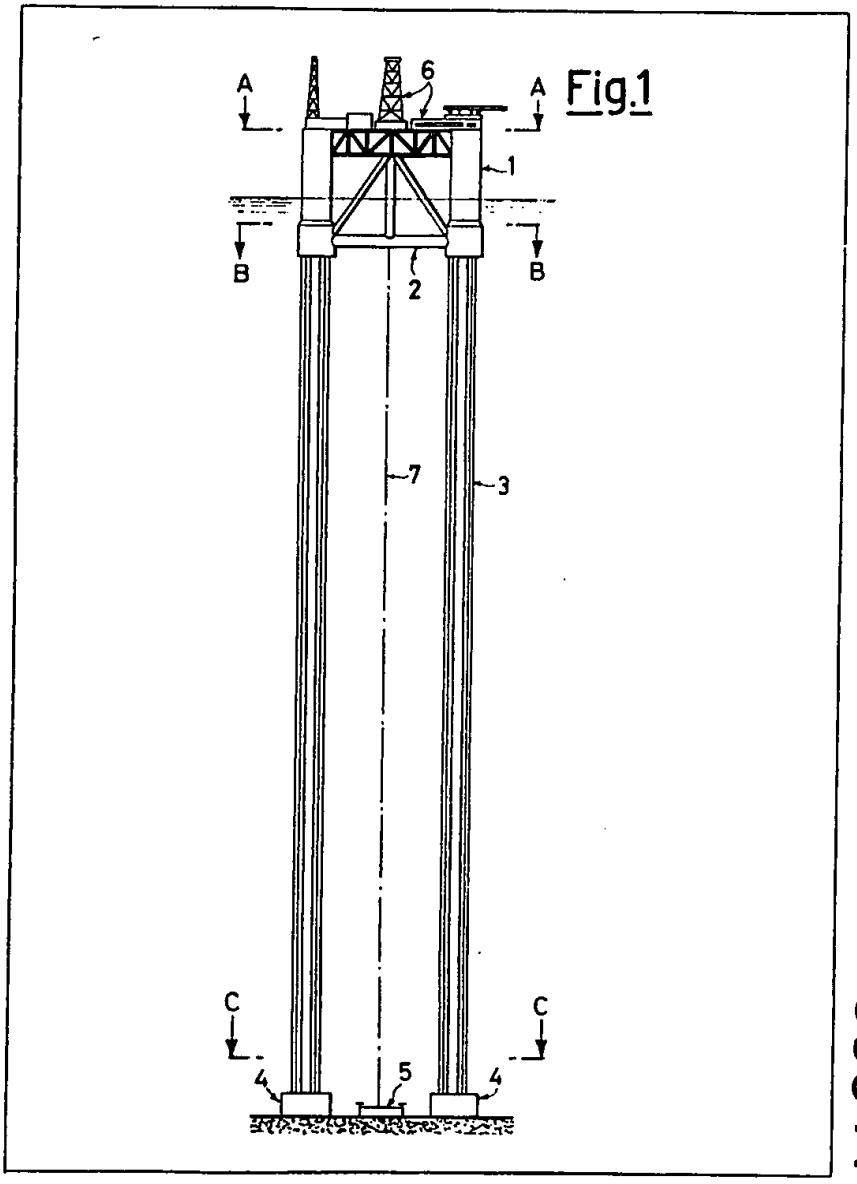

Fig.1

GB 2 081 659 A

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

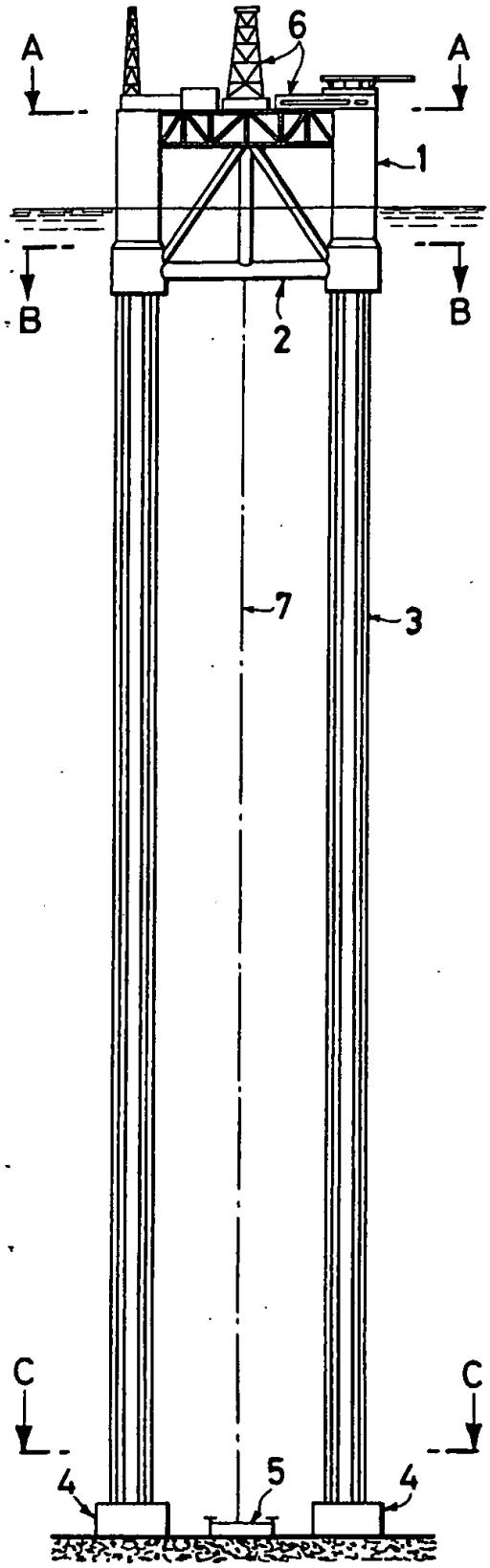

Fig.1

Fig.1A

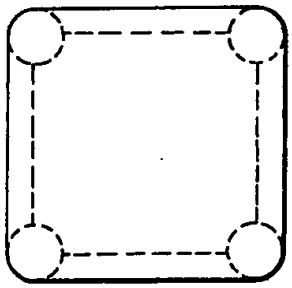

Fig.1B

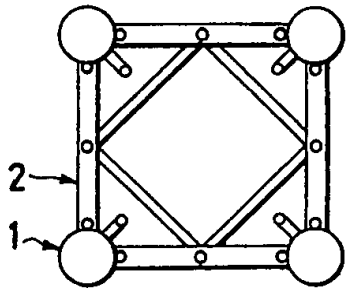

Fig.1C

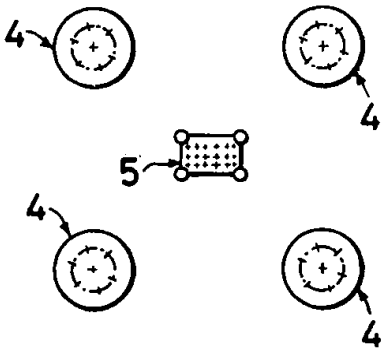

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Fig.2

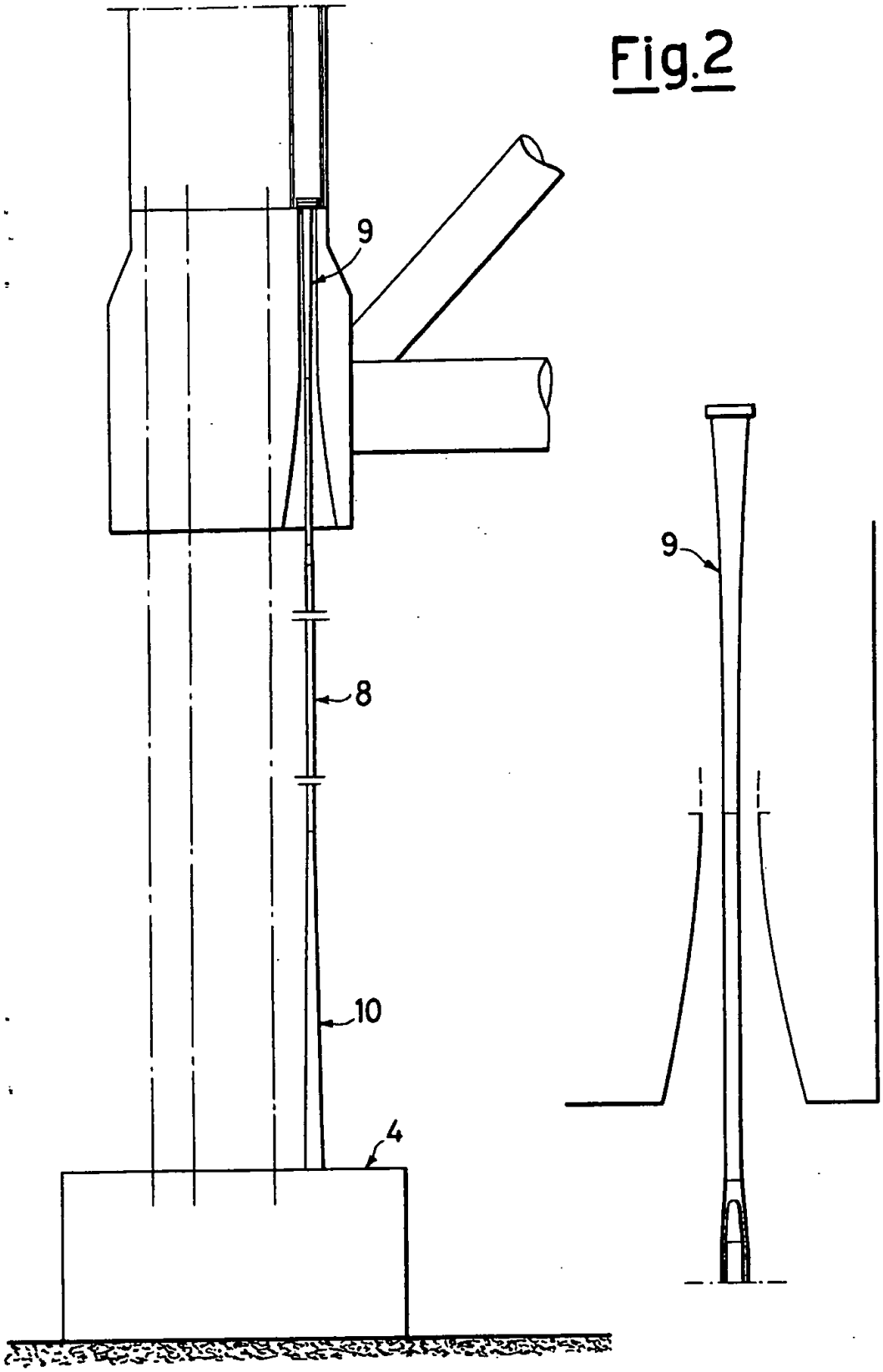


Fig.3

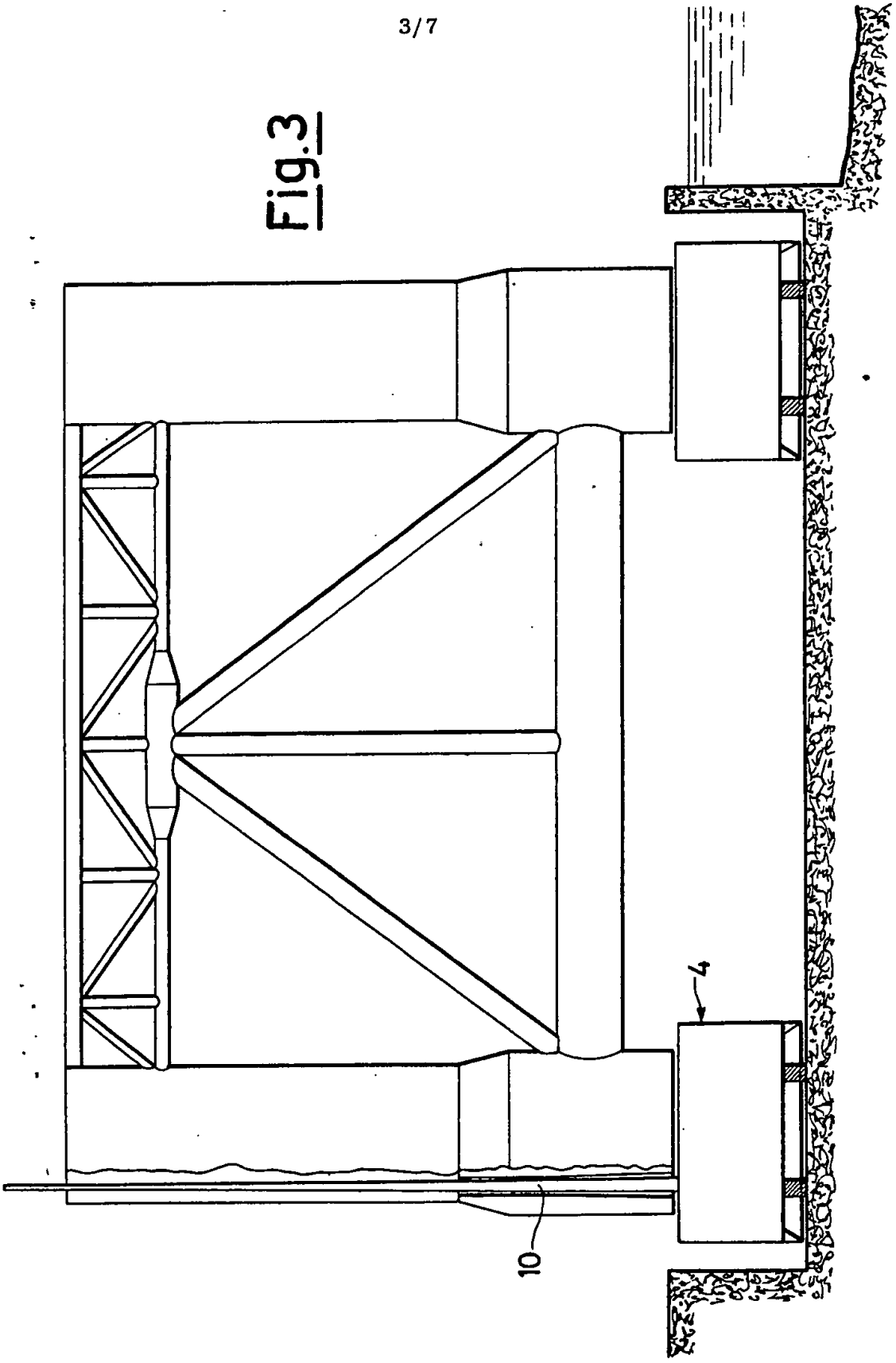


Fig.4

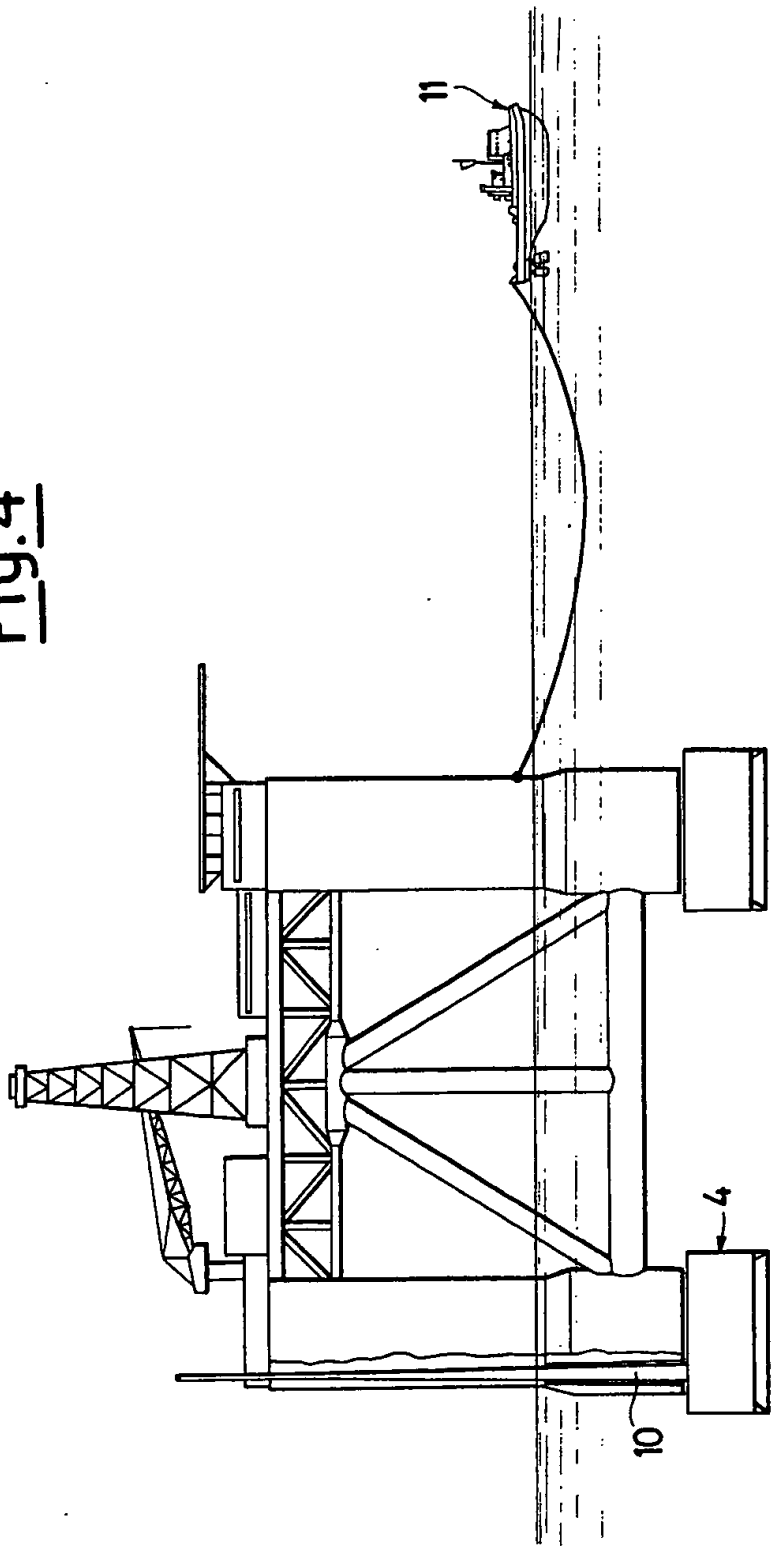


Fig.5

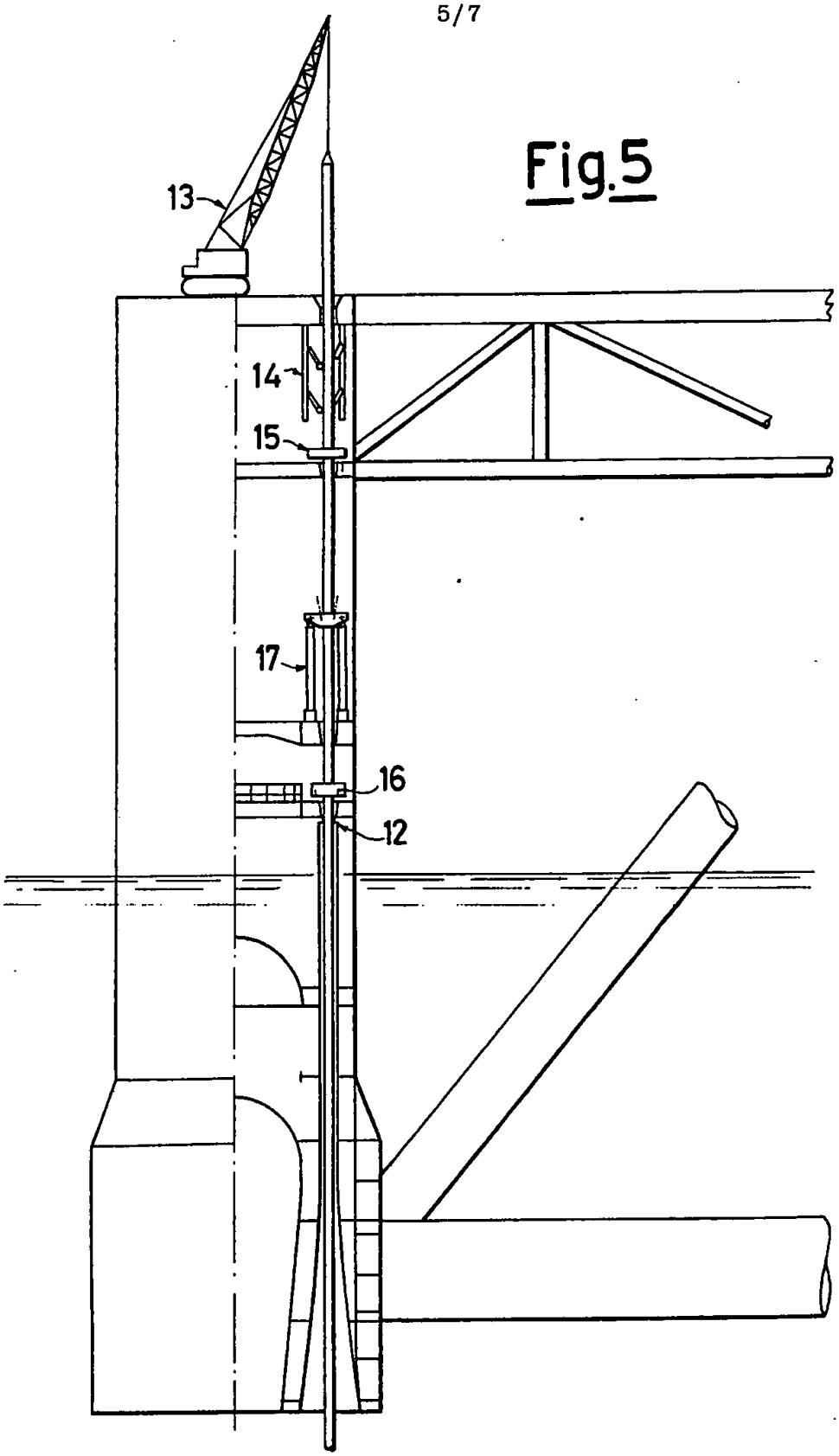


Fig.6

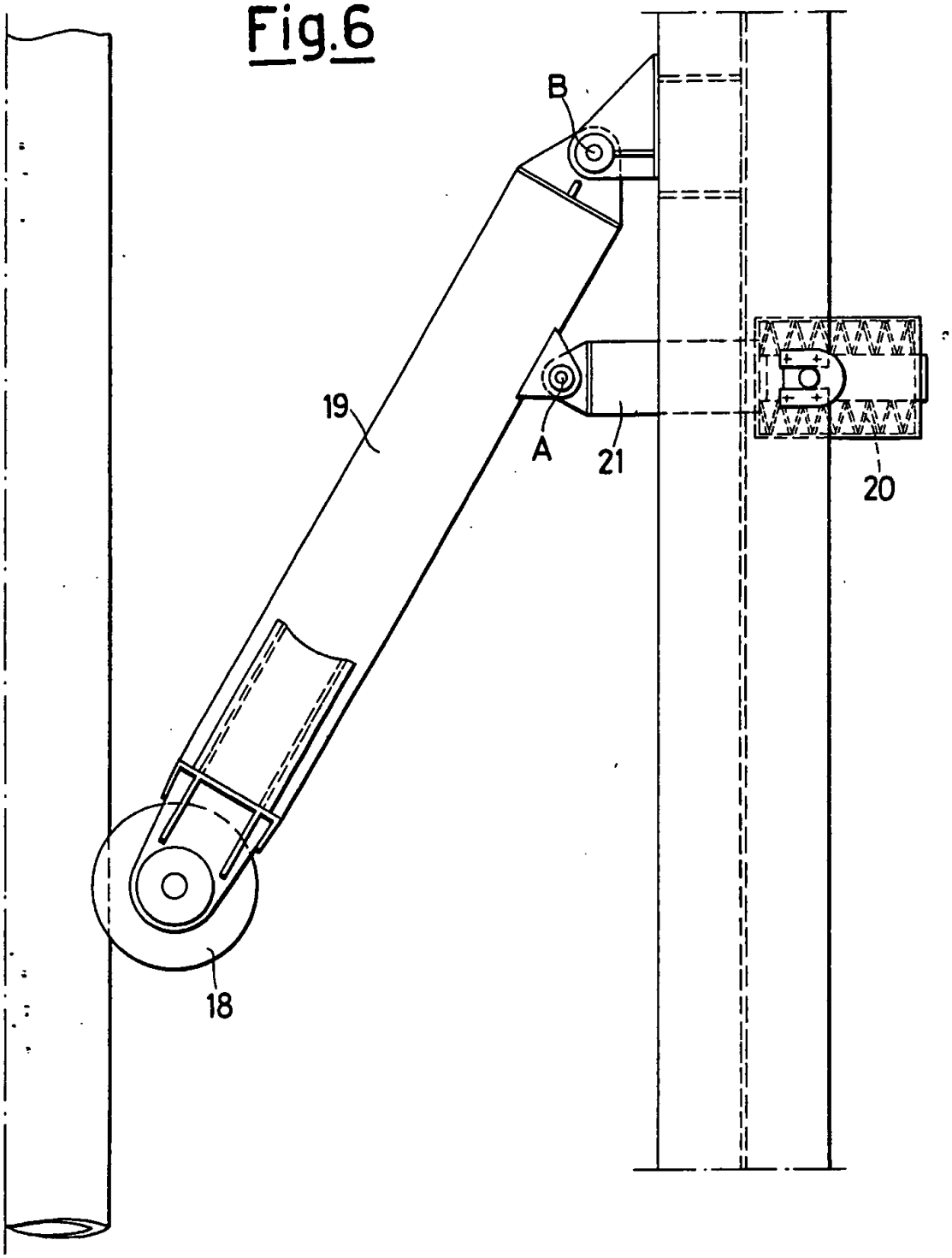
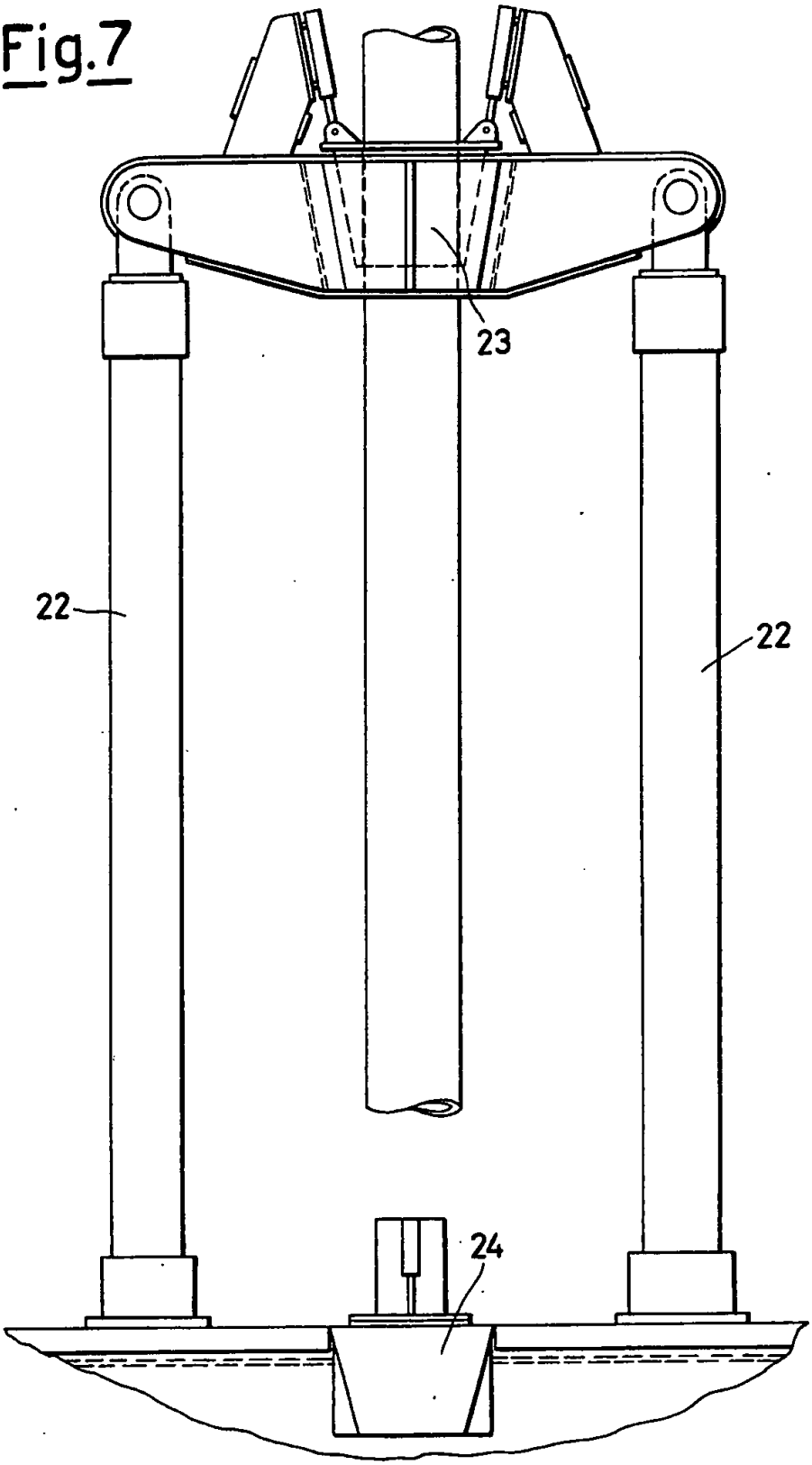


Fig.7



SPECIFICATION
Floating platform assembly

This invention relates to a floating platform assembly for industrial uses and more particularly for drilling for oil in deep waters.

For the exploitation of oil shoals in deep waters (i.e. more than 300 metres), a floating platform anchored by vertical anchoring members held taut can be used, with advantage, instead of a fixed platform. However, a floating platform which is anchored by vertical cables or ropes held taut has the disadvantages that it cannot be used in waters deeper than 500 metres because the yaw and pitch periods of the structure are too long, and that it cannot bear very high payloads. Furthermore, the behaviour of the anchoring cable under stress is not sufficiently well known and periodical replacement of the cable is necessary. A floating platform which is anchored by tubular members connected together by mechanical linking elements such as screw threads or spherical joints, has the defect of a too high initial cost and poor reliability of the mechanical component parts, which must be inspected and replaced whenever necessary.

According to the present invention, there is provided a platform assembly comprising a platform floating on the sea surface and at least one anchoring block resting on the sea bed, the platform being attached to the or each anchoring block by at least one anchoring line kept taut by the buoyancy of the platform and comprising a plurality of tubular sections welded end to end, the uppermost tubular section being attached to the platform and the lowermost tubular section being attached to the anchoring block.

The present invention also provides a platform intended to float on the sea surface whilst being anchored to the sea bed, the platform including means whereby it can be so anchored to the sea bed, which means comprises (a) an anchoring block having a tubular section attached thereto, (b) fixed gripping means for gripping the tubular section so that the anchoring block can be suspended from the platform and so that the platform and suspended anchoring block can be towed to the position at which the platform is to be anchored, (c) positioning means for positioning another tubular section above said first-mentioned tubular section so that the two sections can be welded together, and (d) movable gripping means for gripping said welded tubular sections and for lowering the welded tubular sections and anchoring block upon release of the fixed gripping means, the positioning means and the fixed and movable gripping means enabling other tubular sections to be positioned and welded to the preceding tubular section to form an anchoring line and enabling the anchoring line to be lowered towards the sea bed until the anchoring block rests on the sea bed.

As a rule, the platform comprises a number of vertical uprights, a deck structure for carrying the installations, a horizontal base structure, vertical and sub-vertical component parts which connect the horizontal base structure to the deck, vertical anchoring tubes which connect the uprights to as many anchoring blocks positioned on the sea bed, a number of anchoring blocks, and one or more vertical production conduits which connect the subsea implements (well heads and allied implements) to the installations on the platform deck.

In a preferred embodiment, the present invention provides a floating platform for supporting industrial machinery and more particularly a drilling installation for the production of crude oil, anchored to anchoring blocks arranged on the sea bed by vertical anchoring lines kept under a pulling stress by an excess of buoyancy and composed of sections of steel tubes united together by welding, the central shank of all of said lines having a constant cross-sectional area, the bottom section consisting of a hollow section of steel with a variable cross-sectional area and a diameter which increases in the direction of approach to the anchoring block and with the top section composed of a solid steel section with a diameter and thus a flexural stiffness decreasing from the point of connection to the floating structure, the solid steel section being sustained, when the platform is shifted through a distance greater than a preselected magnitude, by a bell-shaped resting abutment of which the solid steel section takes the curvature. In a method for installing such a floating platform, during the transportation thereof to its operational location, the platform carries on itself the anchoring blocks, whereas the bottom ends of the anchoring lines connected to the blocks are contained in the bell-shaped housings provided in the uprights. Preferably, the anchoring lines, held taut by the weight of the submerged anchoring blocks, are launched section after section while the connections are made by welding, the welding seams being subsequently checked while the anchoring lines are simultaneously lowered by means of hydraulic jacks. Preferably, on completion of the launching of the anchoring lines, the platform is set in its safety position by filling the anchoring blocks with a solid ballast material having an appropriate specific gravity and introduced through the anchoring lines themselves.

For a better understanding of the invention, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 is an elevational view of a floating platform assembly of the invention;

Figure 1A is a sectional view of the assembly taken along line A—A of Figure 1;

Figure 1B is a sectional view of the assembly taken along line B—B of Figure 1;

Figure 1C is a sectional view of the assembly taken along line C—C of Figure 1;

Figure 2 is a sectional view of part of the assembly of Figure 1, on an enlarged scale;

Figure 3 shows the assembly of Figure 1 during the construction thereof;

Figure 4 shows the assembly of Figure 1 being towed to its intended location;

Figures 5, 6 and 7 are more detailed sectional views, on an enlarged scale, of various parts of the assembly of Figure 1.

The hull of the floating platform of the assembly shown in Figures 1, 1A, 1B and 1C consists of four uprights 1 and four horizontal base struts 2. The platform is anchored to the sea bed by an anchoring assembly consisting of four bundles of anchoring lines 3, each of which bundles connects an upright 1 to a respective anchoring block 4 laid on the sea bed around an oil well head 5. The platform, anchored in this manner, can be moved laterally and can also be rotated about a vertical axis. The yaw and pitch to which the platform is subject are almost entirely prevented by the axial stiffness of the bundles of anchoring lines 3. These lines are held taut by the platform as a whole which, in the position shown, has a buoyancy greater than its own weight. One or more pipes 7 connect the oil-extracting system of the oil well head 5 to fittings installed on deck 6 of the platform.

Figure 2 shows the construction of one of the anchoring lines. The line consists of a steel tube 8 having a satisfactory resistance to yield stresses, and having its upper and lower sections 9 and 10 appropriately shaped. Thus, the upper section 9 is a steel rod having a flexural stiffness which decreases from its point of connection to the upright 1, and is such as to limit to a certain extent, the bending stresses caused by horizontal movement of the floating platform. In the most severe weather conditions, and thus, in a limited number of cases, the steel rod, if the lateral shifts are extensive, bears against a bell-shaped or funnel-shaped supporting member and matches the curvature thereof. Thus, wide angles of incline of the anchoring lines 3 can be prevented, thereby restricting the bending stresses thereon.

The lower section 10 of the anchoring line 3 is so designed as to withstand in a fully reliable manner the maximum bending stress caused by the maximum shift of the floating platform. The section has a hollow configuration and is fixed to the anchoring block in order to achieve an optimum exploitation of the structural material.

Figure 3 shows the platform during its construction in a shipyard. The constructional sequence comprises: (a) construction of the anchoring blocks 4 and of the lower sections 10 of the anchoring lines 3, (b) construction of the anchoring assembly for the platform and the deck by usual procedures and typical implements, and (c) pumping water into the dry dock and launching the assembly of the platform and the anchoring blocks.

The assembly, which floats on its anchoring blocks, is towed to still waters. The anchoring blocks are flooded, and the required fittings are installed on the deck of the platform. As an alternative, the deck can be installed on the platform in a single step. In this case, the platform is partially sunk by an appropriate ballast system so that only a portion of the uprights is above the water level. The complete deck, including the fittings thereof, is towed, either afloat or on pontoons, to a position above the platform, whereafter the latter is caused to fully float again and is structurally connected to the deck.

Figure 4 shows the platform, complete with its fittings and anchoring blocks (the latter of which have been flooded and connected to the lower section 10 of the anchoring lines) being towed to the required position by one or more tugboats 11. Once the required position has been reached, the platform is anchored by a temporary catenary anchorage.

The launching procedure for the anchoring lines, one section after another, is described with reference to Figure 5. The lower section 10 of each anchoring lines is already connected to the respective anchoring block end, so that the launching of the first section is carried out at a time. The section which has already been launched is held in position by a pincer 12. The subsequent section is positioned by a swinging crane 13 into a guiding implement 14 and centered by an internal centering tool. Connection of the lower section to the subsequent section is carried out by a speedy and reliable welding procedure at a welding station 15. Downstream of the welding station, there is a station 16 where the welding seams are checked and repaired if necessary.

Once all of the subsequent sections have been welded to the lower sections, the anchoring lines are all simultaneously lowered by hydraulic ram mechanisms 17 which are all actuated all at the same time. This procedure is repeated, the last section welded in place being the steel rod 9. On completion of the launching of the anchoring lines, the anchoring blocks lie on the sea bed.

The guiding implement 14 is shown in more detail in Figure 6. It consists of three rollers 18 disposed symmetrically around the anchoring line, only one roller being shown. Each roller 18 is mounted on a tubular member 19 pivotally mounted at points A and B. A resilient member 20 acting upon a centering implement 21 provides the necessary contacting force between the roller 18 and the section of the anchoring line being positioned.

The hydraulic ram mechanism is shown in more detail in Figure 7. It consists of two jacks 22, a movable latching member or movable pincer 23, and a fixed latching member or fixed clamp 24. During the upward stroke of the jacks 22, the fixed clamp 24 latches the anchoring line. On completion of the upward stroke, the movable pincer 23 is actuated whereas the fixed clamp 24 is deactivated to enable the jacks 22 to effect their downward strokes.

The sequential order of these steps enables all the anchoring lines, and thus their associated anchoring blocks, to be lowered simultaneously. In order to hold the platform safely in position, the anchoring blocks are filled with a solid ballast having an appropriate specific gravity, the strain in

the various anchoring lines is equalized, and the upper sections of the anchoring lines are secured to the platform. The anchoring lines are then prestressed to the desired value by dumping a liquid ballast from ballast tanks of the platform hull.

The illustrated platform has the advantage that its anchoring members consist of simple tubes which are welded and restained at their base to the sea bottom, and which therefore do not give rise to any problems in respect of reliability and fatigue inasmuch as they do not contain mechanical component parts or any intricate structural parts. Furthermore, the platform has pitch and yaw periods which are comparatively short, and thus its dynamic behaviour is good up to depths of 1000 metres or so. Finally, the platform may carry heavy payloads even when the weather is exceptionally rough.

CLAIMS

1. A platform assembly comprising a platform floating on the sea surface and at least one anchoring block resting on the sea bed, the platform being attached to the or each anchoring block by at least one anchoring line kept taut by the buoyancy of the platform and comprising a plurality of tubular sections welded end to end, the uppermost tubular section being attached to the platform and the lowermost tubular section being attached to the anchoring block.

2. A platform assembly as claimed in claim 1, wherein the uppermost tubular section is a solid steel rod, and wherein the other tubular sections are hollow steel sections.

3. A platform assembly as claimed in claim 1 or 2, wherein the uppermost tubular section is outwardly tapered in a direction towards the upper end of the anchoring line, and wherein the lowermost tubular section is outwardly tapered in a direction towards the lower end of the anchoring line.

4. A platform assembly as claimed in any of claims 1 to 3, wherein the upper end of the uppermost tubular section is disposed within a funnel-shaped orifice of the platform, the funnel-shaped orifice serving to prevent the anchoring line from adopting a wide angle of incline.

5. A platform assembly as claimed in any of claims 1 to 4, wherein the platform includes a plurality of uprights and wherein the platform assembly includes a plurality of anchoring blocks equal in number to the number of uprights, each upright being attached to a respective anchoring block by one or more of said anchoring lines.

6. A platform assembly as claimed in any of claims 1 to 5, wherein the anchoring blocks are filled with a solid ballast.

7. A platform assembly as claimed in claim 1, substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

8. A platform intended to float on the sea surface whilst being anchored to the sea bed, the platform including means whereby it can be so anchored to the sea bed, which means comprises (a) an anchoring block having a tubular section attached thereto, (b) fixed gripping means for gripping the tubular section so that the anchoring block can be suspended from the platform and so that the platform and suspended anchoring block can be towed to the position at which the platform is to be anchored, (c) positioning means for positioning another tubular section above said first-mentioned tubular section so that the two sections can be welded together, and (d) movable gripping means for gripping said welded tubular sections and for lowering the welded tubular sections and anchoring block upon release of the fixed gripping means, the positioning means and the fixed and movable gripping means enabling other tubular sections to be positioned and welded to the preceding tubular section to form an anchoring line and enabling the anchoring line to be lowered towards the sea bed until the anchoring block rests on the sea bed.

9. A platform as claimed in claim 8, wherein the positioning means comprises a plurality of rollers disposed around the position in which the tubular section is required to be positioned, and means for urging each roller inwardly towards the position at which the tubular section is required to be positioned.

10. A platform as claimed in claim 8 or 9, wherein the movable gripping means comprises a pair of hydraulic jacks whose piston members are connected by a cross member including pincer members adapted to grip the tubular section.

11. A platform as claimed in claim 8, 9 or 10, the platform having a funnel-shaped orifice through which the tubular section emerges, the funnel-shaped orifice serving to prevent the anchoring line from adopting a wide angle of incline when the platform is anchored to the sea bed.

12. A platform as claimed in claim 8, substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

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